Herding by institutional investors: empirical evidence from French mutual funds

Mohamed El Hedi Arouri, Raphaëlle Bellando, Sébastien Ringuedé, Anne-Gaël Vaubourg

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Mohamed Arouri, Raphaëlle Bellando,
Sébastien Ringuedé and Anne-Gaël Vaubourg

Laboratoire d'Économie d'Orléans
Faculté de Droit, Economie, Gestion
Rue de Blois, BP 6739
45 067 Orléans cedex 02

Abstract

In this paper, we use the traditional herding measure of Lakonishok, Shleifer and Vishny (1992) (LSV indicator) and a more recent measure by Frey, Herbst and Walter (2007) (FHW indicator) in order to assess the intensity of herding by French equity mutual funds and to compare it to institutional herding in other stock markets. We show that when measured with the LSV indicator, institutional herding by French equity funds amounts to 6.5%, which is larger than those reported by other empirical studies on developed stock markets. Our findings also suggest that herding does not monotonically rises with the number of investors trading on a stock-quarter. We also obtain that FHW herding levels are about 2.5 times stronger than those obtained with the traditional LSV measure. Our other results are consistent with those reported by most previous works on developed stock markets. In particular, we observe that herding is stronger in small capitalization than in medium and large capitalization. Moreover herding turns out to be more severe among foreign stocks than among UE-15 or French stocks. Finally, French institutional investors practice feedback strategies: they buy past winners and sell past losers.

JEL Classification: G11, G23
Key words: herding measure, French mutual funds

*Very preliminary version. Do not quote.

1 Introduction

Herding is a behavior that consists in imitating other agents' actions. Although it is refered to in many fields of economics, herding is particularly often invoked to explain financial market anomalies such as the excessive volatility of asset prices or the emergence of financial bubbles. Herding can be practiced by analysts when they issue recommandations or forecasts about assets' prices or firms' earnings but also by investors when they make transactions in financial markets. Among the latter, institutional investors such as funds, banks or insurance companies now carry a very important weight in financial markets. They are also considered as particularly prone to herding. First, they are better informed than individuals about other market participants' transactions. Second, they are particularly sensitive to effects described in the theoretical literature on herding. On the one hand, as explained by Scharfstein & Stein (1990), fund managers do not know their own skill level. They thus herd so that wrong allocation decisions can be attributed to a bad common signal rather than to a lack of skill. On the other hand, in accordance with agency models (Maug & Naik (1996)), relative performance-based payment schemes entice fund managers to herd towards the market index in order to make sure of their payoff[1].

There now exists an abundant empirical literature on institutional herding. A first strand of the literature associates institutional herding to large variations of stocks' holding by institutional investors (Nofsinger & Sias (1999), Kim & Sias (2005), Dasgupta, Prat & Verardo (2007), Sias, Starks & Titman (2007)). Data sets used in these studies only provide the nature of the stocks' owner (institutional or individual) but not his precise identity. This brings a limit of these studies since transactions on large quantities of stocks by a small number of institutional investors can be misinterpreted as herding.

The second stream of literature, in the line of Lakonishok, Shleifer & Vishny (1992), is based on portfolio data. It measures herding as an excessive concentration of transactions on the same side of the market for particular stocks. This literature mainly focuses on American as well as on German and UK mutual and pension funds (Lakonishok et al. (1992), Grinblatt, Titman & Wermers (1995), Oehler (1998), Wermers (1999), Oehler & Chao (2000), Wylie (2005), Haigh, Boyd & Buyuksahin (2006) and Puckett & Yan (2007))[2]. Due to its flexibility of implementation, the indicator proposed by Lakonishok et al. (1992) allows interesting refinement in the analysis of institutional herding. It notably allows to study herding among sub-categories of stocks or funds. It can also be easily used to examine feedback trading strategies as well as the impact of institutional herding on stocks' returns. Among

[1]For very complete reviews of the theoretical literature on herding, see Bikhchandani & Sharma (2001) and Hirshleifer & Teoh (2003).

[2]A few studies have also been conducted on smaller financial markets such as the Polish (Voronkova & Bohl (2005)), the Portuguese (Loboa & Serra (2002)) and the Finnish market (Do, Tan & Westerholm (2006)) as well as on emerging countries (Borensztein & Gelos (2001)).

various arguments put forward against this indicator, the critics by Frey, Herbst & Walter (2007) appears particularly interesting. Resorting to simulations, the authors argue that Lakonishok et al. (1992) underevaluate herding. They thus propose an alternative indicator based on the difference between the empirical variance and the theoretical variance under the assumption of no herding. Applying their indicator to a data set of German mutual funds, they show that herding turns out to be higher than measured with the LSV indicator.

Although a large empirical literature has developed on institutional herding, studies on herding by French institutional investors are still missing. This is mainly due to the fact that portfolio data on French institutional investors have never been available till now. The goal of this paper is to fill this gap. We make use of a totally new data set provided by the Banque de France containing 1 891 French equity OPCVM (Organismes de Placement Collectif en Valeurs Mobilières) between March 1999 and June 2004. OPCVM are collective management entities that encompass SICAV (Société d'Investissement à CApital Variable) and FCP (Fonds Communs de Placement). Mainly controled by banks and insurance companies, OPCVM have a very important success, notably with households. Mutual funds are now among the most significant investors in French financial markets. Their assets under management amounts to about 1 245 billions euros for OPCVM as a whole and 200 billions for equity OPCVM at the end of 2008 (source: Association Française de Gestion, AFG[3]).

In this paper, we use the traditional indicator by Lakonishok et al. (1992) and the recent indicator by Frey et al. (2007) in order to measure the intensity of herding by French OPCVM and to compare it to institutional herding in other financial places. We show that when measured with the LSV indicator, institutional herding by french OPCVM amounts to 6.5%, which is larger than those reported by other empirical studies on developed stock markets. Our findings also suggest that herding does not monotonically rises with the number of investors trading on a stock-quarter. However, it significantly rises when funds considerably change the quantity of a given stock. Whe also obtain that FHW herding levels are about 2.5 times stronger than those obtained with the traditional LSV measure. Our other main findings are consistent with those reported by most previous works on developed stock markets. In particular, although some herding is also observed in large capitalization stocks, herding is stronger in small capitalization than in medium capitalization. Moreover herding turns out to be more severe among foreign stocks than among UE-15 or French stocks. Finally, French institutional investors practice positive feedback strategies: they buy past winners and sell past losers.

The article is organized as follows. Section 2 reviews the empirical literature based on the indicator proposed by Lakonishok et al. (1992). In Section 3, we give

[3]For more details about the French mutual funds industry, see the AFG Website www.afg.asso.fr/.

details about our data and methodology. Results are exposed in Section 4. In Section 5, we provide some extensions. Section 6 concludes.

2 Institutional herding in the empirical literature

2.1 Institutional herding as an excessive concentration of transactions on particular stocks

The most widely used measure of institutional herding is the index proposed by Lakonishok et al. (1992) (below denoted by "LSV indicator"). It is defined as follows:

$H_{LSV,i,t} = \mid \frac{B_{i,t}}{n_{i,t}} - p_t \mid - E \mid \frac{\tilde{B}_{i,t}}{n_{i,t}} - p_t \mid$ where $B_{i,t}$ is the number of institutional buyers of the stock i in t, $n_{i,t}$ the total number of institutional sellers and buyers of the stock i in t, and p_t the probability for an institutional investor to be a buyer in t. As we will see in the next section, the implementation of $H_{LSV,i,t}$ requires precise portfolio data, indicating by which institutional investor each stock of the data set is bought or sold.

$H_{LSV,i,t}$ measures the excess of selling or buying transactions' similarity. The first term of $H_{LSV,i,t}$ measures the propensity of the stock i to be more intensively bought or sold by institutional investors than all stocks as a whole. It is corrected by the second term, which accounts for the natural dispersion of stock transactions by institutional investors. This natural dispersion is defined as the outcome of a binomial distribution, with probability p_t and a number of drawings $n_{i,t}$.

$H_{LSV,i,t} = 0$ means there is no herding among institutional investors while $H_{LSV,i,t} > 0$ indicates herding behavior; the higher $H_{LSV,i,t}$, the stronger herding. For instance, if the proportion of institutional buyers is 50%, $H_{LSV,i,t} = 0.10$ indicates that, in t, the proportion of institutional buyers of the stock i is 40% while the proportion of institutional sellers is 60%. An average indicator H_{LSV} can also be implemented in order to measure institutional herding on the whole market and over the wole data set period.

2.2 The intensity of institutional herding: determinants and implications

The index H_{LSV} has mainly been used in the case of equity transactions by American pension and mutual funds. As shown in Table 1, the resort to H_{LSV} has then been extented in terms of geographical area, as well as in terms of stock and institutional investor categories.

[3]This probability is estimated as the weighted means of $\frac{B_{i,t}}{n_{i,t}}$ all stocks taken together, i.e. $\frac{\sum_i B_{i,t}}{\sum_i n_{i,t}}$.

The first findings of this empirical literature is that institutional herding is very weak in American and Western European markets. It is higher in emerging but also in Finnish, Portuguese and Polish markets because of information opaqueness (Loboa & Serra (2002)), high ownership concentration (Do et al. (2006)) or stock regulation and institutional investor concentration (Borensztein & Gelos (2001)).

Lakonishok et al. (1992), Wermers (1999), Voronkova & Bohl (2005), Do et al. (2006) also establish that small firm stocks are particularly prone to herding behavior. For example, Lakonishok et al. (1992) show that H_{LSV} equals 6.1% for lowest market-capitalization quantile firms while it is only 1.6% for top market-capitalization quantile firms. Information asymetries may also entail stronger herding on stocks issued by TIC firms. This is confirmed by Sharma, Easterwood & Kumar (2005) who show that H_{LSV} is 6.58% for Internet businesses between 1998 and 2001, against 3.86% on the whole american equity market.

Grinblatt et al. (1995) establish that herding by income funds (0.88%) is weaker than herding by growth funds (1.55%) because imitation is particularly attractive for funds whose allocation style is based on firms' fundamental value assessment. Kim & Wei (2001) and Borensztein & Gelos (2001) also obtain that herding is stronger among on-shore than among off-shore funds, the latter being less transparent and more difficult to imitate.

Finally, the LSV indicator has also been used to study feedback trading strategies, which consist in buying high past-return stocks and selling low past-return ones. Grinblatt et al. (1995), Wermers (1999) and Sharma et al. (2005) confirm the existence of feedback trading by american funds. The 'buy herding measure' (the value of $H_{LSV,it,t}$ conditionned on $\frac{B_{i,t}}{n_{i,t}} > p_t$) is higher for stocks with high performance during the previous quarter while the 'sell herding measure' (the value of $H_{LSV,i,t}$ conditioned on $\frac{B_{i,t}}{n_{i,t}} < p_t$) is higher for those who had poor performance. Obtaining opposite results for UK mutual funds, Wylie (2005) concludes they have contrarian strategies.

2.3 Bias in institutional herding measure

The main argument put forward against the LSV indicator is that it may be biased downward[4]. First, the under-evaluation of herding behavior may also come from a

[4]Wylie (2005) suggests that the indicator H_{LSV} could also be biased upward. By construction, H_{LSV} does not account for the prohibition of short-selling (a practice that consist in selling a stock without owning it first) in many financial places. As this reglementary constraint implies a left-truncation of the $\tilde{B}_{i,t}$'s distribution, herding behavior may be over-evaluated. To make the constraint inoperative, Wylie (2005) calculates H_{LSV} only on the subset of stocks *initially* owned in funds' portfolios. He obtains a value of 1.2%, much lower than the one initially found.

Reference	Period	Stocks	Institutional investor	H_{LSV}
Lakonishok et al. (1992)	01/1985-12/1989^t	Equities	769 American pension funds	2.7%
Grinblatt et al. (1995)	01/1974-12/1984^t	Equities	274 American mutual funds	2.5%
Oehler (1998)	01/1988-06/1993^s	Equities	28 German mutual funds	2.9%
Wermers (1999)	01/1975-12/1994^t	Equities	All American mutual fonds	3.4%
Oehler & Chao (2000)	01/1993-12/1995^s	Bonds	57 German mutual funds	2.6%
Borensztein & Gelos (2001)	01/1996-03/1999^m	Equities	467 emerging country mutual funds	7,2%
Loboa & Serra (2002)	01/1998-12/2000^t	Equities	32 Potuguese mutual funds	11.38%
Wylie (2005)	01/1986-12/1993^s	Equities	268 UK mutual funds	2.6%
Voronkova & Bohl (2005)	01/1999-12/2002^a	Equities	17 Polish mutual funds	22.6%
Haigh et al. (2006)	01/2002-09/2006^q	Futures	American hedge funds	9%
	01/2002-09/2006^q	Futures	American brokers and traders	7%
Do et al. (2006)	03/1995-05/2004^m	Equities	32 Finnish banks, mutual funds and brokers	9.9%
Puckett & Yan (2007)	01/1999-12/2004^h	Equities	776 American mutual and pension funds	3.78%
Frey et al. (2007)	01/1998-12/2004^b	Equities	German mutual funds	4.43%

Mentions "d", "w", "m", "q", "b" et "a" in the second column indicate respectively daily, weekly, monthly, quarterly, biannual and annual data. All values reported in the last column are significant.

Table 1: H_{LSV} estimates in the empirical literature

too small number of transactions. If there exists a positive relationship between the intensity of market activity and the level of herding, calculating H_{LSV} with small values of $n_{i,t}$ may bias the indicator downward. Lakonishok et al. (1992), Grinblatt et al. (1995), Wermers (1999), Loboa & Serra (2002) and Wylie (2005) provide the values taken by H_{LSV} when the transaction number below which stocks are excluded from its calculation is progressively reduced. But only Grinblatt et al. (1995) and Wylie (2005) report a monotonic (and positive) relationship between the indicator and the level of the parameter $n_{i,t}$. For instance, in Wylie (2005), $H_{LSV} = 2.5\%$ for $n_{i,t} \geq 5$ and $H_{LSV} = 9\%$ for $n_{i,t} \geq 25$.

Second, according to Oehler (1998), the substraction by p_t purges the indicator from an important dimension of institutional herding, which is the funds' propensity to be massively sellers or buyers, all stocks taken together. Moreover, herding can be weak when measured in terms of *number* of buyers or of sellers but much higher when measured in terms of buying or selling *volume*. Hence Oehler (1998) proposes the following indicator:

$H_{O,i,t} = \mid \frac{BV_{i,t} - SV_{i,t}}{BV_{i,t} + SV_{i,t}} \mid - \mid \frac{\tilde{BV} - \tilde{SV}}{\tilde{BV} + \tilde{SV}} \mid$ where $BV_{i,t}$ and $SV_{i,t}$ are respectively the buying volume and the selling volume on the stock i in t while $\tilde{BV}_{i,t}$ and $\tilde{SV}_{i,t}$ are the transactions' probabilities to be a buying transaction and a selling transaction respectively. Measured with this new indicator, herding turns out to be much stronger: in Oehler (1998), H_O hovers from 78% and 83% according to the estimation period while in Oehler & Chao (2000), it equals 86.2%. However, the definition of market-wide herding by Oehler (1998) and Oehler & Chao (2000) is so large that it may capture many market features that have nothing to do with herding phenomena.

Finally, an interesting development on herding measurement is provided by Frey et al. (2007). Resorting to simulations, they confirm that the LSV indicator underevaluates herding and propose an alternative indicator (below denoted 'FHW indicator'), we will further discuss in 5.2.

Apllied to a set of German mutual funds between 1998 to 2004, the FHW indicator provides a herding measure 2.8 times higher than the one obtained with the LSV indicator.

3 Data

To study institutional herding in the French stock market, we rely on a completely new data set provided by the Banque de France. It contains quarterly portfolio data about 1 891 French equity OPCVM between the first quarter of 1999 and the third quarter of 2005. This represents a total of 20 182 shares i.e. 192 804 stock-quarters. Some equities are quoted only a few times while some others are quoted more than 5 000 times. As we will see now, the structure of the data set is well suited for the implementation of LSV and FHW indicators.

First, for each stock, the data set indicates the weight of the stock in the OPCVM's portfolio, the growth rate of the stock's price and the growth rate of the fund's net value. These information are important because they allow us to compute the so-called 'Growth Rate of the Stocks' Number' (below denoted '$GRSN$'), which tries to evaluate whether a transaction on a given stock is 'important' or not from the fund's point of view. It is calculated as the absolute value of the quarter-on-quarter growth rate of the number of a given stock for a given fund. In the following sections, we investigate whether herding intensity depends on the intensity of a stock transaction for a fund. To do this we successively compute herding indicators on subsamples excluding tradings with low intensity from the fund's point of view, i.e. for which $|GRSN| > k$, with $k = 0$, $k = 0.05$, $k = 0.1$ and $k = 0.15$ respectively (a higher threshold k corresponds to a stronger trading intensity[5])[6].

Other interesting informations are also available. They will allow us to investigate whether herding depend on stocks' characteristics. The data set is segregated into three groups according stocks' capitalization: large capitalization, medium capitalization and small capitalization[7]. The geographical origin of stocks is also provided (French stocks, UE-15 stocks and foreign stocks). The β, the quarter-on-quarter return and the price-to-book-ratio of each stocks are also available.

Finally, the initial data set has been processed in order to exclude stocks for which information or data are missing. For example, $GRSN$ can be calculated for

[5]Funds which introduce a new stock ($GRSN = +\infty$) or liquidate their position ($GRSN = -\infty$) are never excluded by the threshold.

[6]The main drawback of this measure is its sensitivity to the initial holding level. More precise information about sold and bought stocks would have allowed us to compute a more relevant measure.

[7]Unfortunately, we have no information about the thresholds used by the Banque de France for the size segregation.

only 155 492 of them. We also exclude equities for which there exists at least one quarter during which there is only one buyer or one seller. At the end of this process, we have a usable data set of 101 886 stock-quarters. The characteristics of this final data set are depicted in Table 2.

Quarter	**Number of stocks by quarter**						
	1999	2000	2001	2002	2003	2004	2005
1		3 277	3 335	3 489	3 980	4 522	5 135
2	2 598	3 335	3 369	3 764	4 330	4 658	5 422
3	2 674	3 323	3 432	3 793	4 327	4 633	5 546
4	2 760	3 387	3 507	3 838	4 410	5 042	
	On-stock average number of funds by quarter						
	1999	2000	2001	2002	2003	2004	2005
1		17.0	19.9	21.1	19.9	19.2	18.2
2	14.7	17.4	20.1	20.4	19.5	18.5	1.8
3	14.9	18.1	20.4	20.3	19.8	18.2	18.5
4	15.2	19.2	20.4	20.2	19.5	17.6	

Number of stock-quarters by capitalization-category		
Large capitalization	Medium capitalization	Small capitalization
31 923	56 591	52 397
Number of stock-quarters by geographical origin-category		
French	UE-15	Foreign
17 655	23 811	60 420

Table 2: Description of the data set

4 Results

First, we discuss the overall levels of herding by French institutional investors as measured by the LSV indicator. Second, we investigate whether herding intensity changes with stock characteristics and compare our results with those of studies applying the LSV indicator to compared developed stock markets.

4.1 Overall herding levels

Table 3 summarizes the results we obtain through applying the LSV herding measure to the French institutional investors in our sample. The average herding levels are computed over all stock-quarters which were traded by at least five investors. We follow Wermers (1999) and impose a hurdle of five institutional investors trading on a given stock-quarter to measure a 'strict herding'. In fact, less than five investors

trading in the same direction do not seem to qualify as a herd[8].

Table 3 reveals interesting facts. First, the overall level of herding is 6.50%. This result can be interpreted as meaning that if 100 French institutional investors trade a given stock in a given period, then approximately 6 more investors end up on the same side of the market than would be expected if all investors take their decisions randomly and independently. This level of herding is significantly higher than those obtained by previous empirical investigations implementing the LSV herding measure to comparable developed stock markets such as the US, UK and Germany (Lakonishok et al. (1992), Oehler (1998), Grinblatt et al. (1995), Wermers (1999), Wylie (2005) and Puckett & Yan (2007)). This finding can partly be explained by the singularities and institutional differences between the French stock market and the other developed stock markets. In particular, the French market is highly concentrated and most funds are provided by banks and insurance companies[9]. This strong concentration could encourage mimetic behaviors and thus leads to higher herding levels in the French stock market.

Second, our findings suggest that institutional investors herding in France is slightly higher when the number of investors trading on a stock-quarter increases. Similar conclusions have been reported by several previous empirical investigations on institutional herding (Grinblatt et al. (1995) and Wylie (2005)). These findings suggest that the incentive to herd for reputation reasons might be comparatively higher when a large number of other institutional investors are also strongly active in a given stock-quarter. Furthermore, it seems that French institutional investors infer stronger informational signals and disregard their own private information when the number of traders and/or the trading activity in a stock-quarter increase. They may face a considerable reputational cost from acting different from the herd: it is more costly to be alone and wrong than to be with the herd and wrong.

Our findings also show that herding is more pronounced when the growth rate of stocks' number is high. For instance, for stocks traded at least by 10 investors, the herding measure grows from 6.6% when $|GRSN| > 0$ to almost the double 13.80% when $|GRSN| > 0.15$.

Finally, we should mention that the herding measures in Table 3 provide aggregate herding levels over all stock-quarters regardless of the characteristics of these stocks. Therefore, a thorough analysis of different samples is necessary to a better understanding of institutional herding in the French stock market[10].

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[8]Note that herding measures computed over all stock-quarters traded by at least one French institutional investor, not reported here but available upon request from the authors, show too little differences with the results we discuss in the paper.

[9]According to the AFG, the asset management companies (funds families) controlled by banking or insurance groups (some 200 companies among the 500 existing companies), represent 95 % of assets under management.

[10]In order to examine how institutional herding behaved during the internet bubble-period crash,

	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.5%	11%	12.5%	12.3%
	(50249)	(28 309)	(25 318)	(24 747)
$n_{i,t} > 10$	6.6%	11.4%	13.2%	13%
	(32 482)	(15 511)	(13 410)	(12 984)
$n_{i,t} > 15$	6.7%	11.7%	13.8%	13.4%
	(23 881)	(10 271)	(8 680)	(8 358)
$n_{i,t} > 20$	6.9%	12%	14.3%	13.8%
	(18 557)	(7 457)	(6 115)	(5 880)

Figures in brackets indicate the number of quarter-stocks.

Table 3: Estimates of H_{LSV}

4.2 Herding intensity and stocks' characteristics

4.2.1 Herding intensity and stocks' market capitalization

We first examine whether institutional herding in the French stock market varies with the size of firms[11]. Thus, based on firms market capitalization, we segregate our stock-quarters sample into three groups: large, medium and small firms. In theory, we should expect higher herding for small firms because investors receive less information from these firms. Moreover, according to Wermers (1999), informational cascades are more likely among small firms because institutional investors put a relatively larger weight on what the herd is doing and less weight on their own noisy private information. Therefore, institutional herding arises from inferring information from each others trades (informational cascades) and the average herding should be higher in small capitalization stocks. Furthermore, institutional investors may share a strong aversion to small capitalization stocks (Falkenstein (1996)). The agency theory can equally be used to justify a higher expected herding in small capitalization stocks. In this theory, the basic rule is that 'it is better to fail conventionally than to succeed unconventionally'. Thus, institutional investors should be more sensible to holding small, bad performing stocks than to holding large, bad performing stocks, since the latter are held by many concurrent institutional investors.

we have applied LSV measure during three sub-periods: before, during and after the crash. One would assume that herding on the buy-side may be higher in times of bull markets, driving asset prices away from theoretical values. Alternatively, herding on the sell-side may be bigger in times of bear markets because of competition between institutional investors. However, our findings reveal no significant differences. In other words, French institutional herding was not more pronounced during the internet crash than during the calm period.

[11]Our tests, not reported here but available upon request from authors, show that herding is not different based on Price to Book Ratio.

Therefore, herding is likely to be higher in small capitalization stocks[12]. Finally, as short-selling impossibility mainly affects small capitalization stocks, that kind of constraint may also explain more severe herding (on the buying side) among small capitalization stocks.

Table 4 shows, as expected, that institutional investors herding in the French stock market is larger for small capitalization stocks than for large ones. The more fund trading intensity assessed by $|GRSN|$, the larger the difference between herding in small and large capitalization stocks. The evidence is less clear according to the number of traders. However, when the fund trading intensity is high (high —GRSN—), institutional herding in small capitalization stocks sharply rises with number of traders. For instance, when$|GRSN| > 0.15$, the level of herding in small stocks traded by at least 20 managers is 20.9% , whereas in small stock traded by at least 5 managers it is only 15.2%. On the other hand, our findings reveal that institutional herding in the French stock market is higher for large stocks than for medium stocks. This result may partly arise from correlated signals (investigative herding). In fact, Sias (2004) establishes that correlation between signals is higher in large stocks with less noisy signals because institutional investors use same indicators. Furthermore, institutional investors share similar preferences for liquidity and size, such that high herding can be observed in large capitalization stocks (Gompers & Metrick (2001) and Pinnuck (2004)). Taken together, our results suggest that herding is consistent with the preference of institutional investors to hold large capitalization stocks. But due to information asymmetries and similar preferences, these investors strongly imitate others in trading the smaller stocks.

[12]This can explain why small firms are massively sold by fund managers before performance disclosure (a practice called 'window dressing').

	Large capitalization firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.7%	11.1%	12.6%	12.2%
	(17 380)	(11 973)	(11 020)	(10 833)
$n_{i,t} > 10$	6.9%	11.5%	13.4%	12.9%
	(12 996)	(8 299)	(7 511)	(7 325)
$n_{i,t} > 15$	7.1%	12%	14%	13.4%
	(10 706)	(6 389)	(5 598)	(5 447)
$n_{i,t} > 20$	7.3%	12.4%	14.7%	13.9%
	(9 271)	(5 087)	(4 326)	(4 199)
	Medium capitalization firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6%	10.5%	11.9%	11.8%
	(25 464)	(13 583)	(12 012)	(11 719)
$n_{i,t} > 10$	6.2%	11%	12.7%	12.6%
	(16 117	(6 346)	(5 279)	(5 080)
$n_{i,t} > 15$	6.3%	10.9%	13%	12.9%
	(11 185)	(3 526)	(2 845)	(2 697)
$n_{i,t} > 20$	6.4%	10.9%	13%	12.9%
(8 054)	(2 193)	(1 681)	(1 585)	
	Small capitalization firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	7.7%	13%	14.9%	15.2%
	(6 605)	(2 541)	(2 110)	(2 029)
$n_{i,t} > 10$	7.4%	13%	15.8%	16.5%
	(3 113)	(796)	(569)	(529)
$n_{i,t} > 15$	7.2%	13.7%	17.1%	19%
	(1 849)	(328)	(216)	(193)
$n_{i,t} > 20$	7.3%	13.7%	18.7%	20.9%
	(1 154)	(161)	(95)	(83)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.

Figures in brackets indicate the number of quarter-stocks.

Table 4: Estimates of H_{LSV} according to the market capitalization of firms

4.2.2 Herding intensity and stocks' geographical origin

Next we examine the hypothesis that institutional herding is greater in foreign stocks than in French stocks. In fact, investors know better domestic stocks and receive

lower precision earnings information from foreign firms and are more likely to disregard this information if the consensus opinion is different. The information-based and cascades models suggest that herding is more likely to occur when public and private information is more difficult to obtain, to understand, and to use in portfolio management. Thus, we should expect more pronounced herding in foreign stocks. Fortunately, our dataset enables us to segregate our stock-quarters sample into three groups on the base of geographical origin of the stock. The three groups are: French firms, Euro-15 firms and others (foreign firms). Table 5 reports the institutional herding measures we obtain for the three groups. As expected, herding is more severe for foreign stocks than for French stocks (except for $|GRSN| > 0$). More interestingly, herding is larger in Euro-15 stocks than in French stocks. French institutional investors know Euro-15 firms better than foreign firms, but less than French firms. Thus, they herd much more in foreign and European stocks[13].

[13]Again we have computed sell and buy side herding, but we found that they are not significantly different. We have also measured herding based on the betas of stocks (offensive and defensive stocks). The results reveal no evidence that institutional herding in the French stock market in offensive stocks differs from that is defensive stocks.

	Foreign firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.6%	11.6%	13.1%	12.9%
	(27 379)	(13 800)	(11 885)	(11 523)
$n_{i,t} > 10$	6.7%	12.1%	13.9%	13.8%
	(16 023)	(5 814)	(4 545)	(4 422)
$n_{i,t} > 15$	6.9%	12.4%	14.8%	14.9%
	(10 631)	(2 999)	(2 158)	(2 005)
$n_{i,t} > 20$	7.2%	13.1%	16.2%	16.1%
	(7 571)	(1 616)	(1 001)	(894)
	UE-15 firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.2%	11.1%	12.4%	12.1%
	(13 325)	(8 752)	(8 147)	(8 029)
$n_{i,t} > 10$	6.3%	11.7%	13.2%	12.9%
	(9 404)	(5 683)	(5 166)	(5 048)
$n_{i,t} > 15$	6.4%	12.2%	13.8%	13.5%
	(7 440)	(4 114)	(3 670)	(3 572)
$n_{i,t} > 20$	6.6%	12.8%	14.5%	14.1%
	(6 087)	(3 171)	(2 755)	(2 681)
	French firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.6%	9.5%	11.5%	11.1%
	(9 545)	(5 757)	(5 286)	(5 195)
$n_{i,t} > 10$	6.7%	10.1%	12.5%	12%
	(7 055)	(4 014)	(3 599)	(3 514)
$n_{i,t} > 15$	6.8%	11.3%	12.9%	12.2%
	(5 810)	(3 158)	(2 852)	(2 781)
$n_{i,t} > 20$	6.9%	11.5%	13.2%	12.5%
	(4 899)	(2 670)	(2 359)	(2 305)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.

Figures in brackets indicate the number of quarter-stocks.

Table 5: Estimates of H_{LSV} according to the geographical origin of firms

4.3 Herding intensity and stocks' return

Several papers indicate that positive feedback trading strategies (momentum investment strategies) are commonly followed by institutional investors (Grinblatt et al. (1995) and Glaser & Weber (2004)). As institutional investors are subject to regular performance evaluation and comparison to other funds, they are mainly interested in short-term returns. Furthermore, institutional investors may trade in the same direction due to window dressing policies which consist in selling stocks with negative past returns 'past losers'. Thus, we attempt in this section to investigate whether investor trade together based on past returns. In other words, we determine whether institutional herding is more common in stocks having low or high past returns. In Tables 6 and 7 we partition stocks in three groups of similar size (each group contains 1/3 of the stocks' population) according to the returns of the last quarter. We distinguish between buy-side herding and sell-side herding. Table 6 show that institutional herding is slightly larger among stocks having extreme past returns. Sell-herding is more severe for low past-performance stocks. Whereas, Table 7 indicates that buy-herding is more severe for high past-performance stocks. Thus, institutional investors in the French stock market seem to use positive feedback strategies: they buy past winners and sell past losers. Note however that comparison between Tables 6 and 7 suggest that French institutional investors buy high past return stocks more frequently than they low past return stocks. This finding offers new evidence of disposition effect in the case of French fund managers. As they dislike incurring losses much more than they enjoy making gains, investors hold stocks that have lost value and are impatient to sell those stocks that have risen in value (Shefrin & Statman (1985)).

In short, our findings suggest some evidence in favour of the positive feedback trading strategies by French institutional investors. These investors seem to focus on short-term returns. Furthermore, the window dressing strategies appear to being to some extent commonly followed.

	Low past-performance			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.6%	8.3%	9.2%	9.7%
	(8 249)	(3 663)	(3 168)	(3 283)
$n_{i,t} > 10$	6.6%	8.5%	9.5%	10.1%
	(5 262)	(1 967)	(1 649)	(1 705)
$n_{i,t} > 15$	6.7%	8.5%	9.8%	10.5%
	(3 895)	(1 258)	(1 011)	(1 053)
$n_{i,t} > 20$	6.9%	8.7%	10.2%	10.6%
	(3 051)	(913)	(669)	(697)
	Medium pas-performance			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.1%	6.9%	7.3%	7.3%
	(8 609)	(3 120)	(2 636)	(2 772)
$n_{i,t} > 10$	6.2%	7.1%	7.4%	7.6%
	(5 668)	(1 654)	(1 324)	(1 415)
$n_{i,t} > 15$	6.6%	7.3%	7.7%	7.8%
	(4 266)	(1 065)	(829)	(889)
$n_{i,t} > 20$	6.6%	7.2%	7.4%	7.5%
	(3 337)	(756)	(541)	(592)
	Large past-performance			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6%	7.2%	7.9%	8.2%
	(8 311)	(2 725)	(2 175)	(2 254)
$n_{i,t} > 10$	6.2%	7.9%	9.2%	9.4%
	(5 223)	(1 307)	(975)	(1 016)
$n_{i,t} > 15$	6.5%	8.4%	9.5%	6.6%
	(3782)	(811)	(603)	(634)
$n_{i,t} > 20$	6.6%	8.5%	10.2%	10.3%
	(2933)	(555)	(387)	(410)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.

Figures in brackets indicate the number of quarter-stocks.

Table 6: Estimates of sell-herding (H_{LSV} calculated on stocks for which $\frac{B_{i,t}}{n_{i,t}} < p_t$) according to previous quarter stocks' return

	Low past-performance			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	5.7%	10.8%	12%	11.6%
	(7 276)	(5 074)	(4 676)	(4 386)
$n_{i,t} > 10$	6%	11.2%	12.6%	12.1%
	(4 834)	(2 905)	(2 557)	(2 354)
$n_{i,t} > 15$	6.2%	11.4%	13.1%	12.6%
	(3 512)	(1 940)	(1 687)	(1 544)
$n_{i,t} > 20$	6.5%	11.9%	13.6%	13%
	(2 733)	(1 441)	(1 255)	(1 146)
	Medium past-performance			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	6.3%	12.1%	13.7%	13.4%
	(8 265)	(6 248)	(5 738)	(5 417)
$n_{i,t} > 10$	6.4%	12.2%	14.3%	14%
	(5 453)	(3 608)	(3 215)	(2 988)
$n_{i,t} > 15$	6.6%	12.7%	14.8%	14.5%
	(4 050)	(2 462)	(2 140)	1 970)
$n_{i,t} > 20$	6.8%	13.1%	15.5%	14.9%
	(3 128	1 814	1 566	1 447
	Large past-performance			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	7.1%	14.1%	16.3%	15.9%
	(8 779)	(6 901)	(6 374)	(6 089)
$n_{i,t} > 10$	7.2%	14.5%	17%	16.7%
	(5 615)	(3 777)	(3 414)	(3 233)
$n_{i,t} > 15$	7.3%	14.4%	17.3%	16.8%
	(4 083)	(2 537)	(2 224)	(2 086)
$n_{i,t} > 20$	7.3%	14.7%	17.6%	17.1%
	(3 163)	(1 831)	(1 559)	(1 452)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.

Figures in brackets indicate the number of quarter-stocks.

Table 7: Estimates of buy-herding (H_{LSV} calculated on stocks for which $\frac{B_{i,t}}{n_{i,t}} > p_t$) according to previous quarter stocks' return

5 Extensions

5.1 Discussion on the FHW methodology

In a recent paper, Frey et al. (2007) examine the relevance of the LSV herding measure. Using Monte Carlo simulations, they show that this measure is suited to test whether herding exists or not. However, the authors establish that in case of herding, using the LSV measure systematically underestimates herding. In fact, the second term in LSV formula (adjustment term) is too high in case of positive herding. According to their simulations, the bias in LSV is increasing with the herding level. Furthermore, this bias depends on the number of traders in a stock-quarter. Thus, comparisons of herding measures based of LSV indicator across stocks, periods, subsamples lead to potentially distorted results. Based on a simple model of trading, Frey et al. (2007) introduce a new measure of herding, the FHW indicator. This indicator goes from the basic idea of the LSV indicator and assesses the excess dispersion of trades on the buy or the sell side in case of herding. However, they use the second moment rather than the first absolute moment. More precisely, the herding level is measured by the normalized difference between the empirical variance and the expected variance using a binominal distribution under no herding:

$H^2_{FHW,i,t} = \left[[\frac{B_{i,t}}{n_{i,t}} - p_t]^2 - E_{h,0}[\frac{\tilde{B}_{i,t}}{n_{i,t}} - p_t]^2 \right]$

The stronger herding, the higher the difference between the empirical and theoretical variances. Table 11 in Appendix shows that our own Monte Carlo simulations corroborate those of Frey et al. (2007) and suggest that the FHW herding measure has better statistical proprieties than the traditional LSV measure. In short, the LSV indicator should be used to test whether herding exists or not while the new FHW indicator may be employed to measure the extent of herding as well as to make comparisons across stocks, periods, and markets.

5.2 Using the FHW indicator

In what follows, we compare the herding levels by institutional investors in the French stock market as measured by the traditional LSV indicator and the recent FHW indicator. As suggested by our simulations, the LSV indicator systematically underevaluates herding. Thus, this exercise enables us to empirically assess the bias in herding when measured by the LSV indicator. Table 8 reports the overall levels of herding by the institutional investors in the French stock market as measured by FHW indicator. This table is to be compared with Table 2. As expected, FHW herding measure is significantly larger than that obtained by LSV indicator. Indeed, the overall herding level rises from 6.5% to 16.50%. In contrast to results reported in Table 2, the herding levels are not systematically increasing in the number of traders on a given stock-quarter. The slight positive link between the herding levels and the number of traders in Table 2 may partly be due to the bias inherent in the

traditional LSV herding indicator (Frey et al. (2007)). Therefore, higher levels of herding in stock-quarters traded by few institutional investors in the French stock markets are only detected with the FHW measure of herding. Taken together, our findings are consistent with those of Frey et al. (2007) for institutional investors in the German stock market.

More interestingly, the positive link between herding levels and fund trading intensity as measured by the indicator we introduce in this paper (the GRSN) is confirmed by the implementation of the new FHW herding measure. Indeed, Table 8 shows that the herding levels monotonically increase when the fund trading intensity measured by $GRSN$ rises.

Next, we briefly discuss the results obtained using the FHW herding indicator taking into account stocks characteristics[14]. Table 9 reports herding levels for small, medium and large capitalization stocks. As shown by the traditional LSV measure, institutional investors in the French stock market herd much more in small capitalization stocks. However, as we expect the LSV indicator underevaluates the herding and the FHW herding levels are about 2.5 times stronger than those obtained employing the traditional LSV measure. More importantly, again herding measured by FHW does not monotonically rises with the number of traders, but it does with the fund trading intensity as assessed by $GRSN$. The results in Table 10 are consistent with information-based and cascades models and corroborate those reported in Table 5: herding is more pronounced when public and private information is more difficult to obtain. Thus, herding levels are considerably larger in foreign than in French stocks.

	$\lvert GRSN\rvert > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	16.5%	21.5%	22.7%	23%
	(50249)	(28 309)	(25 318)	(24 747)
$n_{i,t} > 10$	15.1%	20%	21.1%	21.4%
	(32 482)	(15 511)	(13 410)	(12 984)
$n_{i,t} > 15$	14.6%	19.1%	20.6%	20.9%
	(23 881)	(10 271)	(8 680)	(8 358)
$n_{i,t} > 20$	14.3%	18.8%	20.1%	20.4%
	(18 557)	(7 457)	(6 115)	(5 880)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.
Figures in brackets indicate the number of quarter-stocks.

Table 8: Estimates of H_{FHW}

[14]Frey et al. (2007) do not propose specifications of buy- versus sell-herding measures. Thus, we cannot check the hypothesis of positive feedback strategies by institutional investors using the FHW herding indicator.

	Large capitalization firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	16%	22.7%	24.6%	24.2%
	(17 380)	(11 973)	(11 020)	(10 833)
$n_{i,t} > 10$	14.1%	21.7%	23.9%	23.6%
	(12 996)	(8 299)	(7 511)	(7 325)
$n_{i,t} > 15$	14.7%	21.6%	23.9%	23.4%
	(10 706)	(6 389)	(5 598)	(5 447)
$n_{i,t} > 20$	14.5%	21.6%	24%	23.5%
	(9 271)	(5 087)	(4 326)	(4 199)
	Medium capitalization firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	16.3%	23.7%	25.6%	25.5%
	(25 464)	(13 583)	(12 012)	(11 719)
$n_{i,t} > 10$	15.1%	22.5%	24.5%	24.4%
	(16 117)	(6 346)	(5 279)	(5 080)
$n_{i,t} > 15$	14.7%	21.4%	23.9%	23.8%
	(11 185)	(3 526)	(2 845)	(2 697)
$n_{i,t} > 20$	14.3%	20.8%	23.2%	23.2%
	(8 054)	(2 193)	(1 681)	(1 585)
	Small capitalization firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	20%	28%	30.4%	30.7%
	(6 605)	(2 541)	(2 110)	(2 029)
$n_{i,t} > 10$	17.6%	25.7%	28.9%	29.5%
	(3 113)	(796)	(569)	(529)
$n_{i,t} > 15$	16.3%	25.8%	29.6%	31.4%
	(1 849)	(328)	(216)	(193)
$n_{i,t} > 20$	15.8%	25.5%	30.7%	32.7%
	(1 154)	(161)	(95)	(83)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.

Figures in brackets indicate the number of quarter-stocks.

Table 9: Estimates of H_{FHW} according to the market capitalization of firms

	Foreign firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	17.3%	25.2%	27.3%	27.2%
	(27 379)	(13 800)	(11 885)	(11 523)
$n_{i,t} > 10$	15.7%	23.7%	26%	26%
	(16 023)	(5 814)	(4 545)	(4 422)
$n_{i,t} > 15$	15.1%	23.1%	26.2%	26.4%
	(10 631)	(2 999)	(2 158)	(2 005)
$n_{i,t} > 20$	14.9%	23.4%	27.1%	27.1%
	(7 571)	(1 616)	(1 001)	(894)
	UE15 firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	16.2%	23.3%	24.8%	24.6%
	(13 325)	(8 752)	(8 147)	(8 029)
$n_{i,t} > 10$	15%	22.4%	24.2%	24%
	(9 404)	(5 683)	(5 166)	(5 048)
$n_{i,t} > 15$	14.6%	22.3%	24.1%	23.8%
	(7 440)	(4 114)	(3 670)	(3 572)
$n_{i,t} > 20$	14.4%v	22.4%	24.4%	24%
	(6 087)	(3 171)	(2 755)	(2 681)
	French firms			
	$\|GRSN\| > k$			
	$k = 0$	$k = 0.05$	$k = 0.1$	$k = 0.15$
$n_{i,t} > 5$	16.2%	20.5%	23.1%	22.7%
	(9 545)	(5 757)	(5 286)	(5 195)
$n_{i,t} > 10\%$	15%	19.8%	22.5%	22%
	(7 055)	(4 014)	(3 599)	(3 514)
$n_{i,t} > 15\%$	14.5%	19.3%	22.2%	21.7%
	(5 810)	(3 158)	(2 852)	(2 781)
$n_{i,t} > 20\%$	14.1%	18.9%	22%	21.5%
	(4 899)	(2 670)	(2 359)	(2 305)

Whatever the considered category, $p_{i,t}$ is calculated on the whole data set.
Figures in brackets indicate the number of quarter-stocks.

Table 10: Estimates of H_{FHW} according to the geographical origin of firms

5.3 Conclusion

This paper offers the first empirical investigation of herding by institutional investors in the French stock market. We use two different measures of herding: the traditional

LSV indicator and the recent FHW indicator. We establish that the widely used LSV indicator systematically underevaluates the herding and the FHW herding levels are about 2.5 times stronger than those obtained employing the traditional LSV measure. Our empirical results show also that high levels of herding in stock-quarters traded by few institutional investors are only detected with the FHW measure of herding. More interestingly, based on the both measures we find that herding levels by French institutional investors are higher than those reported by previous empirical investigations on developed stock markets. This finding is partly explained by the institutional differences between the French market and compared developed markets. On the other hand, our findings suggest that herding does not monotonically rises when the number of investors trading on a stock-quarter increases. However, herding levels increase significantly with our measure of the intensity of fund trading, the GRSN.

Our other main findings are consistent with those reported by most previous works on developed stock markets. In particular, herding is stronger in small capitalizations and in foreign stocks. These findings might be attributed to less information available and hence to institutional investors being more inclined to follow others or the consensus. Some herding is also observed in large capitalization stocks likely because of informational herding as large capitalizations are closely followed by analysts and investors. Indeed, the later relay on the same information. Finally, institutional investors in the French stock market seem to use positive feedback strategies: they buy past winners and sell past losers. However they buy high past return stocks more they frequently sell low past return stocks.

There are several avenues for future research. First, further research should be carried out in order to improve the available indicators of herding. Second, future works should empirically assess the impact of herding by French institutional investors on stock prices. In other words, it would be too interesting to check whether institutional herds is destabilising or stabilising stock markets in France. third, herding intensity and its impact on stock prices can be expected to vary across different economic industries. Thus, a sectoral analysis of herding by institutional investors in the French stock market would be informative. Finally, as our sample gathers low-frequency data, it would be interesting to refine our investigation on herding using daily or weekly data.

6 Appendix

True herding=5%					
Number of investors	**Number of stocks**	**LSV**	**1st term of LSV**	**2nd term of LSV**	**FHW**
5	20	0.30%	19%	18.7%	0.9%
	100	0.30%	19%	18.7%	2.2%
	1000	0.40%	19.1%	18.7%	4.2%
20	20	0.80%	9.6%	8.8%	2.8%
	100	0.90%	9.6%	8.8%	4.2%
	1000	0.90%	9.7%	8.8%	5%
50	20	1.30%	6.9%	5.6%	4%
	100	1.30%	6.9%	5.6%	4.9%
	1000	1.40%	7%	5.60%	5%
True herding=15%					
Number of investors	**Number of stocks**	**LSV**	**1st term of LSV**	**2nd term of LSV**	**FHW**
5	20	3.3%	22%	18.7%	11.9%
	100	3.30%	22.1%	18.8%	14.4%
	1000	3.30%	22.1%	18.8%	15
20	20	7.10%	15.9%	8.8%	14.9%
	100	7%	15.8%	8.8%	15%
	1000	7%	15.8%	8.8%	15%
50	20	9.50%	15.1%	5.6%	14.9%
	100	9.50%	15.1%	5.6%	15%
	1000	9.40%	15.1%	5.7%	15%
True herding=30%					
Number of investors	**Number of stocks**	**LSV**	**1st term of LSV**	**2nd term of LSV**	**FHW**
5	20	12.70%	31.4%	18.7%	29.6%
	100	12.70%	31.5%	18.8%	30%
	1000	12.70%	31.4%	18.7%	30%
20	20	21.20%	30%	8.8%	30%
	100	21.20%	30%	8.8%	30%
	1000	21.20%	30%	8.8%	30%
50	2024.40%	30%	5.6%	30%	
	100	24.40%	30%	5.6%	30%
	1000	24.40%	30%	5.6%	30%

Table 11: Monte-Carlo simulations

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